

How much do farmers value their independence?

Nigel Key *

Economist, Resource Economics Division, Economic Research Service, U.S. Department of Agriculture, Room N4161, 1800 M Street N.W., Washington, DC 20036

Received 26 November 2002; received in revised form 1 November 2003; accepted 17 February 2004

Abstract

A farmer's decision to contract or produce independently depends on the distribution of income and the nonpecuniary attributes associated with both business arrangements. The benefits to growers from contracting (such as risk reduction) may be overestimated if the nonpecuniary benefits enjoyed by independent producers (such as the right to make management decisions and own the commodity produced) are not accounted for. This study uses data from a U.S. national survey of hog producers to estimate (1) the difference in expected net returns between contracting and independent production, (2) the premium a representative farmer would pay for the risk reduction provided by a contract, and (3) the premium a farmer would pay for the nonpecuniary benefits associated with independent production. Results indicate that growers have a strong preference for autonomy—with moderately risk-averse growers being willing to pay more for the attributes of independent production than they would for the risk-reducing benefits of a contract.

JEL classification: Q12, L23, D80

Keywords: Agricultural contracts; Autonomy; Nonpecuniary benefits; Risk

1. Introduction

The growing importance of contracting in U.S. agriculture has motivated efforts to understand farmers' incentives to contract versus produce independently. Most research in this area has assumed that risk aversion plays a primary role in farmers' contracting decisions, and has failed to consider the role of nonpecuniary attributes of contracting versus producing independently. Examples of nonpecuniary benefits from independent production include the sense of responsibility associated with making management decisions, the sense of independence that comes from being self-supervised, and pride related to ownership of production. Not accounting for the nonpecuniary benefits enjoyed by independent producers may result in an overestimation of the benefits to growers from contracting, such as risk reduction. This study aims to address this problem by estimating, for the case of the U.S. hog sector, both the value to a representative grower of the risk reduction provided by a production contract and the nonpecuniary net benefits associated with independent farming.

Contracting is a significant and growing part of U.S. agriculture. In 2001, 10% of farms reported contracting and 36% of

the total value of agricultural production was produced under contract (USDA, 2001). Contracts are used almost universally in the production of poultry, eggs, and sugar beets and are commonly used in producing hogs (61% of the value of production in 2001), cotton (52%), fruit (59%), and vegetables (37%). The last decade has seen a rapid increase in contracting in the hog sector, with the share of total production under contract increasing from only 5% in 1992 to 40% in 1998 (McBride and Key, 2003). Hayenga et al. (1996) estimated that 87% of the market hogs in 1993 were sold in a cash market with 13% either owned by packers or contracted for by packers. By 2001 and 2002, Grimes and Meyer (2002) report that only 17% of processed hogs were sold in the cash market—with the remainder procured via some type of marketing agreement.

The increased use of contracts may have important implications for economic efficiency and grower welfare. Understanding growers' incentives to contract is important in the analyses of this structural change. Much past research has cited risk reduction as a major incentive for contracting (e.g., Johnson and Foster, 1994; Knoeber and Thurman, 1995; Martin, 1997; Parcel and Langemeir, 1997). Production contracts reduce risk by eliminating input- and output-price risk for growers. For example, in the case of a typical production contract to finish hogs, a contractor provides feed, feeder pigs, veterinary care, managerial assistance, and marketing services. Growers

*Tel.: 202-694-5567; fax: 202-694-5756.

E-mail address: nkey@ers.usda.gov (N. Key).

are paid a fee for feeding and caring for the animals, which may be based on animal weight gain and feed efficiency. Hog production contracts lower price risks for growers mainly because growers' fees do not depend on input prices or hog prices.

While reducing risk, production contracts also reduce farmer autonomy (Gillespie and Eidman, 1998). Growers may derive utility from certain attributes associated with independent production, such as a sense of responsibility, independence, and pride derived from making farm management decisions, being self-supervised, and owning the commodity they produce. These benefits are likely to be greater under independent production because production contracts usually require growers to surrender some control over the production process, and submit to various rules regarding management decisions.¹ In addition, production contracts often designate legal ownership of the crop or livestock to the contractor. Contracting may also impose nonpecuniary costs on growers—for example, contracting may cause growers to feel vulnerable to changes in contract terms or other forms of manipulation by contractors. These types of grower concerns are demonstrated by recent legislative efforts in the United States to regulate agricultural contracts such as the Producer Protection Act (Boehlje et al., 2001).

Farmers who value “autonomy” need to be compensated by contractors for giving up the nonpecuniary net benefits associated with independent production. In their study of vertical integration in the pork and beef industry, Hayenga et al. (2000) note:

The loss of independence is perhaps the largest disadvantage to the farmer involved in a contract, along with the potential inequities in risk and return sharing. The farmer must evaluate whether the income stability, greater access to operating or facility loans, and/or access to a confirmed market are a fair exchange for the loss of independence involved in the contract.

While a farmer's decision to contract versus produce and market goods independently likely depends on nonpecuniary benefits associated with each arrangement, many past studies have considered only the role of risk aversion and the distribution of returns in this decision.² For example, Johnson and Foster (1994) determined the breakeven levels of risk aversion at which point farmers switch their order of preferences for different types of

contracts and independent production. Parcell and Langemeier (1997) estimated the minimum level of contract payments required for growers with different levels of risk aversion to prefer contract production to independent production. Both studies assumed that risk-neutral independent growers would be indifferent to accepting a contract if they could earn the same expected return under both arrangements.

When growers prefer autonomy, the minimum level of payments required for growers to accept a contract will be greater, *ceteris paribus*. Consequently, studies that incorrectly assume that growers are indifferent between the attributes of independent or contract production will tend to underestimate the contract payment necessary for growers to accept a contract. Similarly, studies that infer attitudes toward risk based on the premium that contractees are willing to pay to enter a contract will underestimate grower risk aversion—attributing a relatively small (or even negative) risk premium to a grower's lack of risk aversion rather than to a grower's preference for autonomy.

The goal of this study is to estimate the nonpecuniary net benefits of farming independently compared to farming under a production contract—paying particular attention to the importance of risk reduction in the decision to contract or remain independent. Economists have long been interested in measuring the value that workers place on attributes of their jobs. Examples of this research include measuring the value lawyers place on “public-interest” versus private-sector work (Goddeeris, 1988); the willingness to pay for job safety (e.g., Viscusi and Hersh, 2001); the nonpecuniary benefits of self-employment (e.g., Hamilton, 2000); and the nonpecuniary rewards associated with having a leadership position (Cavalluzzo, 1991). In agriculture, Gillespie and Eidman (1998) surveyed 20 hog farmers to elicit utility functions and preferences for various contract structures and then used this information to estimate an autonomy premium.

Rather than using contingent valuation methods to estimate the value farmers place on independence (e.g., Gillespie and Eidman, 1998), this article develops a new method that uses information on actual returns to contract and independent feeder-to-finish hog production. First, information from a national survey of 477 feeder-to-finish hog producers and 10 years of monthly price data are used to estimate the mean and coefficient of variation of net returns from independent hog production. Second, a treatment effects model is applied to the same national survey to estimate how much of the difference in per unit income between contract and independent operations can be attributed to contracting. For a given level of risk aversion, the estimated variation in contract and noncontract income is used to compute the risk premium—the amount a representative grower would pay for the risk-reducing benefits of a contract. Finally, the autonomy premium—the nonpecuniary net benefits from independent production—is estimated as the sum of the expected difference in contract and noncontract income and the risk premium. The next section provides a theoretical basis for the empirical approach used in Sections 3 and 4.

¹ In contrast to production contracts, marketing contracts offer growers many of the same nonpecuniary benefits as independent production. Marketing contracts are usually limited to the terms of sale of a commodity—specifying the price (or pricing mechanism), quantity to be delivered, and time of delivery. Under a typical marketing contract, growers are not bound to follow a particular production process and they maintain ownership of their product.

² In addition to risk aversion, the decision whether to contract or produce independently may be influenced by how each organizational strategy affects the ability to obtain financing. Contracting may alter the risk-return trade-off for lenders providing greater borrowing capacity to contract producers, which in turn could allow contract growers to operate on a larger scale and earn a higher return on their equity (Barry et al., 1997; Boehlje and Ray, 1999). The incentives to contract will also depend on transaction costs associated with obtaining inputs and marketing a product (Hobbs, 1997).

2. Theory

Synthesizing earlier work by Rothschild and Stiglitz (1970) and Diamond and Stiglitz (1974) and others, Newberry and Stiglitz (1981) show that the benefits to a risk-averse farmer of an income-stabilization scheme can be expressed in terms of the change in expected income under the scheme and a “risk premium” (the benefit of the risk reduction to the farmer). Newberry and Stiglitz relate the risk premium to the farmer’s attitude toward risk, summarized by the coefficient of relative risk aversion—a measure of the curvature of the utility function. In this section, we extend the analysis of Newberry and Stiglitz to consider the case where farmers have different preferences over the attributes of independent and contract production. Because agricultural contracts change both the mean and variance of income, it is possible to estimate for contracts both the change in expected income and a “risk premium.” In addition, when farmers have preferences over the *method* of production then it is also possible to estimate an “autonomy premium”—a measure of the nonpecuniary benefits from producing independently. We define the autonomy premium in this section.

If farmers prefer the attributes of independent production to those of contract production and each business arrangement earns the same certain fixed income Y_0 , then growers will always experience a greater utility under independent production compared to under contract: $U^I(Y_0) > U^C(Y_0)$. Suppose there is an equilibrium in the market for products under contract such that farmers are indifferent between contract and independent production such that $EU^I(Y^I) = EU^C(Y^C)$, where Y^I and Y^C are the uncertain net returns from independent and contract production, respectively.³ For a grower to accept a contract, a contractor must offer an uncertain income Y^C that compensates the grower for the lower utility resulting from his or her loss of autonomy. In other words, the “benefit” from contracting that results from the change in expected income and lower risk must equal the autonomy loss. It follows that the “autonomy premium” can be defined as this benefit—the amount α that an independent farmer would be willing to pay for the income distribution available under contract: $EU^I(Y^I) = EU^I(Y^C - \alpha)$.

Following Newberry and Stiglitz (1981, pp. 92–93), the benefit α to a scheme that changes the mean and variance of income can be approximated as the change in expected income plus a risk premium ρ :

$$\alpha \cong (\bar{Y}^C - \bar{Y}^I) + \rho, \quad \text{where}$$

$$\rho = \frac{1}{2} R[(CV^I)^2 - (CV^C)^2] * \bar{Y}^I. \quad (1)$$

The risk premium is a function of the coefficient of relative risk aversion R , and the reduction in the coefficient of variation of income due to contracting.⁴ The autonomy premium α is positive if the farmer prefers autonomy. If the risk premium is zero (the farmer is risk neutral), then the autonomy premium equals the gain in expected income from contracting. If contracting and independent production have the same expected income, then the risk premium must equal the autonomy premium—the insurance value the farmer receives from the contract must just compensate for the loss of autonomy. Note that (1) places no *a priori* restrictions on the sign or relative magnitude of the autonomy premium— α can be positive or negative and bigger or smaller than the risk premium.

Finally, define K_t as the additional income in period t that can be earned by contracting rather than producing independently: $Y_t^C = Y_t^I + K_t$. To the extent that the contract provides income insurance, we would expect K_t to be greater in low-price years and smaller in high-price years (it could be positive or negative in good or bad years). It follows that: $EK = \bar{Y}^C - \bar{Y}^I$. Hence, from (1), the autonomy premium equals the risk premium plus EK , the *expected* change in income from contracting.

Fig. 1 illustrates the risk, autonomy, and contract premia for the simple case where income from independent production can be low Y_L^I with probability p or high Y_H^I with probability $(1 - p)$, and income from contracting Y^C does not vary ($Y^C = EY^C$). In the figure, $U^I(Y)$ is the utility from income given that the farmer is independent and $U^C(Y)$ is the utility from income if the farmer contracts. The utility functions are concave because the farmer is risk averse. As shown in the figure, contracting provides a lower level of utility $U^C(Y)$ at any level of income, for the reasons discussed above. The expected independent income is defined as $EY^I = pY_L^I + (1 - p)Y_H^I$ and the expected utility is defined as $EU^I(Y^I) = pU(Y_L^I) + (1 - p) \times U(Y_H^I)$. In equilibrium, the utility from contracting equals the expected utility from independent production, as shown by the middle horizontal dotted line.

The certainty equivalent income Y_{CE}^I is defined as the income that a grower would receive with certainty that would make them as well off as the gamble: $U(Y_{CE}^I) = pU(Y_L^I) + (1 - p) \times U(Y_H^I)$. By definition, if the contract income does not vary, the risk premium ρ is the difference between the expected income under independent production EY^I and the certainty equivalent income Y_{CE}^I .⁵ If the farmer contracts, his risk is lowered, he loses autonomy, and he receives a different expected income. Because the farmer is paid his reservation wage, the benefit that contracting provides in terms of the reduction in risk and the

³ This condition holds if contractors have monopsony power and can hold contractees to their reservation wage. This condition will also hold in equilibrium in a competitive market for contracts if farmers can choose to produce independently or contract depending on which provides greater expected utility (Key and Roberts, 2002). To illustrate, consider the counterfactual: if contracting provided greater expected utility than independent production, then farmers would leave the spot market and begin contracting which would increase the supply of product under contract, bidding down the contract price (or fee). In contrast, if contracting provided lower expected utility than independent production, then farmers would leave contracting and contractors would have to pay a higher contract price.

⁴ By definition, $R = -\bar{Y}U''(\bar{Y})/U'(\bar{Y})$; $CV^I = \sigma_I/\bar{Y}^I$; $CV^C = \sigma_C/\bar{Y}^C$.

⁵ It can be shown (e.g., Newberry and Stiglitz, 1981, pp. 69–73) that for the situation described in the graphical analysis, $\rho = \frac{1}{2} R[(CV^I)^2] * \bar{Y}^I$, which is consistent with (1).

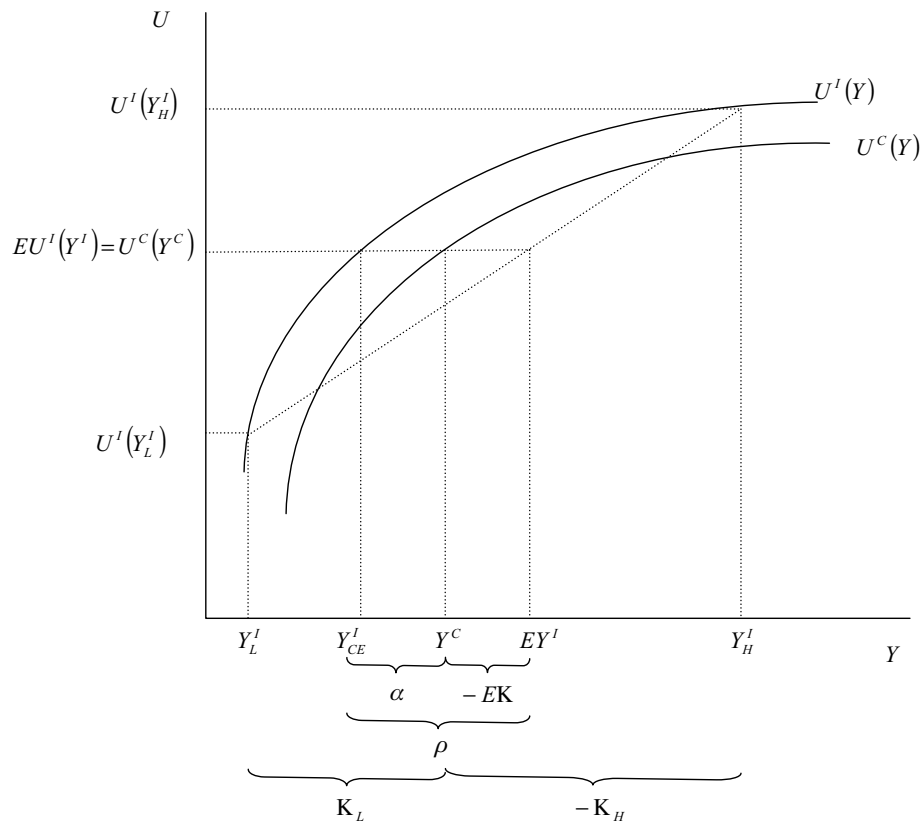


Fig. 1. Risk and autonomy premia. Y_L^I , Y_H^I = Income from independent production in a low- and high-income period, respectively; Y_{CE}^I = certainty equivalent income from independent production; EY^I = expected income from independent production; Y^C = income from contract production (= EY^C in figure because contract income is constant), ρ = risk premium, α = autonomy premium, K_L , K_H = difference in income between contract and independent operations in low and high income periods ($Y^C - Y_L^I$, $Y^C - Y_H^I$), EK = expected difference in income between contract and independent production ($EY^C - EY^I = Y^C - EY^I$).

change in expected income must just compensate for the loss of autonomy. Hence, the autonomy premium α is the risk premium plus the difference in expected income (positive or negative) between contracting and independent production. In the figure, the risk premium is larger than the autonomy premium, but this is not necessarily the case.

For the income distribution illustrated in Fig. 1, in low-price years the contracting premium is positive, while in high-price years the premium is negative. Our survey was conducted in 1998, a year with unusually low prices for finished hogs. As a result, it would not be surprising if K_t was positive in 1998, whether or not contracting has a lower expected income than independent production.

3. Data and methods

It is possible to compute the risk and autonomy premia as functions of the relative risk aversion coefficient using (1), given estimates of the mean and coefficient of variation of income for both independent and contract operations. We obtain these estimates in two steps. First, we estimate the mean and coefficient of variation of income for a representative independent hog producer using historical product and input price data. Second, we

estimate the difference in income between contract and independent operations in the survey year using a treatment effects model. Finally, conditional on an explicit relationship between the variation in contract and independent income, it is possible to estimate the mean and coefficient of variation of contract income.

Data are from three sources: operator and farm-level data are from the 1998 USDA Agricultural Resource Management Study (ARMS) of the hog sector, county-level characteristics are from the 1997 U.S. Agricultural Census, and monthly finished hog, feeder pigs, and feed prices are from the National Agricultural Statistics Service. Because of the broad differences in production techniques among various types of hog operations, we limit the ARMS data to feeder pig-to-finish operations. Feeder pig-to-finish operations are defined as those on which feeder pigs (30–80 pounds) are purchased/placed, finished, and later sold/removed for slaughter at a weight of approximately 200–260 pounds. This group of producers accounted for about a third of total finished hog farms and production in 1998.

Table 1 reports the results of tests of equal means between contract and independent operations for the variables used in this section. In testing the difference of means (and in all the regressions in the article), the survey data were weighted to

Table 1
Test of equality of means for independent and contracting operations

| Variables | Mean independent operators | Mean contract operators | <i>t</i> -stat | Prob > <i>t</i> |
|---|----------------------------|-------------------------|----------------|-------------------|
| <i>Operator and operation characteristics</i> | | | | |
| Age (years) | 50.6 | 47.0 | 3.78 | 0.000 |
| Education (years) | 13.0 | 12.9 | 0.06 | 0.953 |
| Years in hog business | 24.1 | 14.8 | 9.03 | 0.000 |
| Total farm assets (100,000 US\$) | 7.62 | 8.70 | −1.25 | 0.211 |
| <i>Regional characteristics</i> | | | | |
| Northern state (MI, MN, SD, WI)* | 0.194 | 0.232 | −1.02 | 0.306 |
| Southern or Eastern state (AL, AR, GA, KY, MO, NC, SC, TN, VA)* | 0.100 | 0.236 | −4.03 | 0.000 |
| Western state (CO, KS, NE, OK, UT)* | 0.159 | 0.067 | 3.20 | 0.001 |
| Central Midwestern state (IA, IL, IN, OH)* | 0.548 | 0.463 | 3.17 | 0.064 |
| County aver. net cash return per farm (1,000 US\$) | 34.86 | 46.54 | −4.64 | 0.000 |
| County aver. swine sales per farm (1,000 US\$) | 23.63 | 70.73 | −6.80 | 0.000 |
| <i>Output and income</i> | | | | |
| Hog production (cwt) ¹ | 2,678 | 10,672 | −9.67 | 0.000 |
| Scale class 1 (cwt < 750) ² | 0.374 | 0.061 | 10.39 | 0.000 |
| Scale class 2 (750 ≤ cwt < 2,250) | 0.309 | 0.204 | 2.64 | 0.009 |
| Scale class 3 (2,250 ≤ cwt < 6,000) | 0.229 | 0.235 | −0.15 | 0.881 |
| Scale class 4 (6,000 ≤ cwt) | 0.089 | 0.501 | −11.80 | 0.000 |
| Net return per unit (US\$/cwt) ³ | −24.33 | −5.12 | −9.89 | 0.000 |
| Number of observations | 233 | 244 | | |

Note: All data are from the 1998 USDA-ERS ARMS except county-level variables, which are from the 1997 U.S. Agricultural Census. Means are weighted to account for survey design. Prob > |*t*| is the two-tailed significance probability under the null hypothesis of equal means.

*Dummy variable equal to 1 if statement is true or located in region, 0 otherwise.

¹Hog production is measured as hundredweight of hogs sold or removed under contract less hundredweight of hogs purchased or placed under contract, plus hundredweight of inventory change.

²The scale class variables are indicator variables indicating which hog production category the farm belongs to. Hog production is defined in Eq. (1).

³Net return per unit is defined as revenue from hog production less the costs of all inputs to hog production except unpaid labor that were incurred by the operator per hundredweight of hog produced. For independent producers, revenue equals the gross value of hog production. For contract producers, revenue equals contract fees for hogs produced under contract plus the gross value of production for hogs produced without a contract.

account for sample design. As shown in the table, both contract and independent operators earned negative per unit net returns on average in 1998. Net return per unit is defined as revenue from hog production less the costs of all inputs to hog production except unpaid labor that were incurred by the operator per hundredweight of hog produced. For independent operators, revenue equals the gross value of hog production. For contract operators, revenue equals contract fees for hogs produced under contract plus the gross value of production for hogs produced without a contract. Contract operators earned significantly more on average than independent operators, losing 19.21 US\$ less per hundredweight of hog produced.

Table 1 highlights several clear differences between the two groups. On average, contractees are younger and have much less experience in the hog business. Contractees do not have significantly more total assets employed in farming, yet they produce over three times as much pork. Contract and independent producers are also located in different geographical regions, and contract operations are much larger than independent producers.

3.1. Income from independent hog production

The mean and coefficient of variation of independent hog income are estimated using the 1998 ARMS survey and 10 years

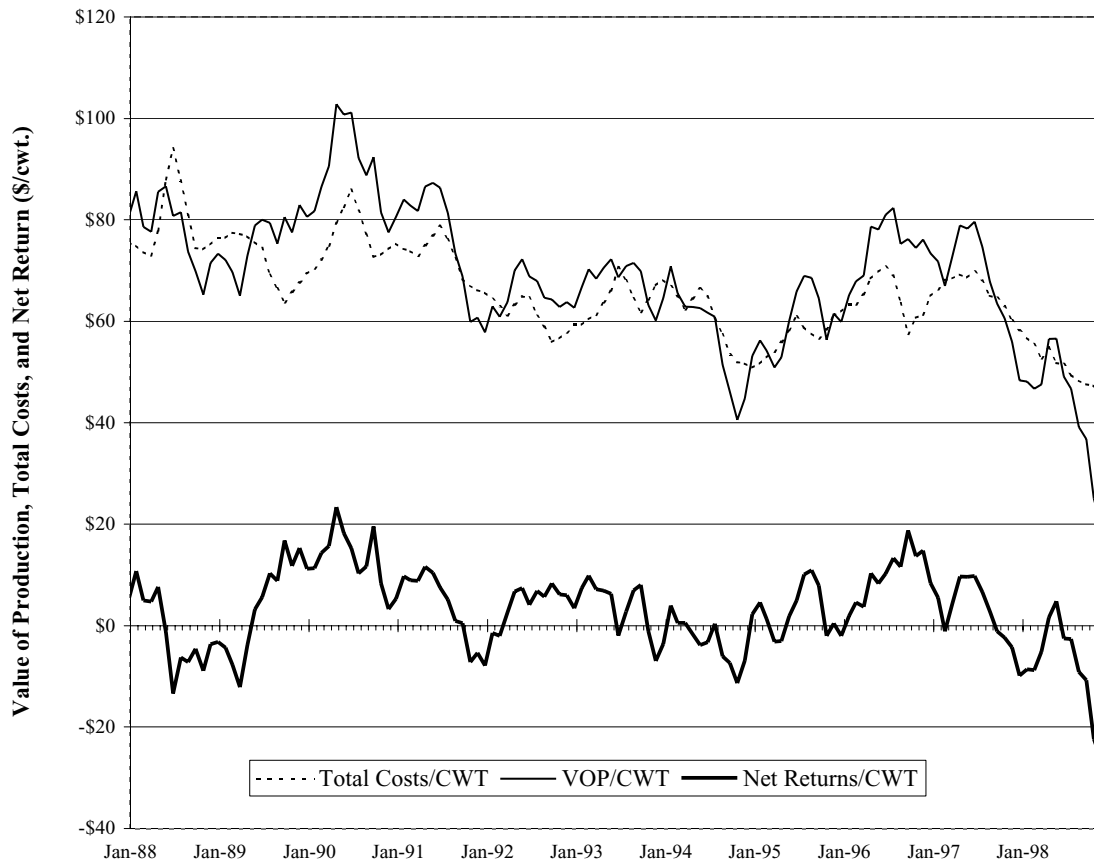
of monthly hog and feed prices. Using the ARMS survey year (1998) as the base year, monthly income was approximated for the 10-year period prior to the survey. Hog farm income in month *t* was approximated by adjusting the value of hog production, the feed costs, and the feeder pig costs by the observed prices in month *t*. Technological change over time was proxied by assuming that total cost decline over time at a constant rate of 0.1612% per month. Details on how the income time series was constructed are presented in the Appendix. The estimated monthly value of production, total costs, and net income from 1988 to 1998 are illustrated in Fig. 2. From the data series, the expected independent hog farm return is estimated to be 15,838 US\$ (5.91 US\$/cwt.) having a standard deviation of 20,197 US\$.

3.2. Income from contract hog production

To estimate the expected contract income Y^C in 1998 we estimate how much more income an independent operation would have earned had it contracted—that is, K_{98}

$$Y_{98}^C = Y_{98}^I + K_{98}. \quad (2)$$

In the survey year of 1998, prices were well below their historical mean. Consequently, we would expect K_t in 1998 to be



Source: Value of production, total costs, and net returns in 1998 from USDA ARMS. Estimates for other years computed using USDA-NASS monthly price data (see Appendix for details). All values are in 1998 dollars.

Fig. 2. Value of production, total costs, and net returns per hundredweight for a representative independent hog producer from 1988 to 1998.

larger than average. For convenience, we define κ_t as the *per unit* change in income, so $K_t = \kappa_t q_t$, where q_t is total output.

To measure the per unit change in income due to contracting, while controlling for differences in operator, operation, regional, and scale characteristics, we could use a linear regression

$$y_i = X_i \beta + C_i \kappa + \varepsilon_i, \quad (3)$$

where y_i is the per unit net return to hog production for operation i , X_i is a vector of exogenous characteristics, C_i is a dummy variable indicating whether or not the operation contracts. However, it is possible that unobservable variables are correlated with both the farmer's decision to contract and farm income. For example, farmer ability which is unobservable could be positively correlated with the decision to contract. This correlation could lead to an under-estimation of the impact of contracting on income, if it were not accounted for (Greene, 1993, p. 714).

To account for possible sample selection bias, we specify a "treatment effects" model. The model introduces an additional equation that models the decision to contract:

$$C_i^* = Z_i \gamma + u_i \quad (4)$$

$$C_i = 1 \quad \text{if } C_i^* > 0, 0 \text{ otherwise,}$$

where C_i^* is a latent variable measuring net benefits to contracting compared to independent production, and Z_i is a vector of farm and regional characteristics. If the latent variable is positive, then the dummy variable indicating contracting C_i equals 1, and 0 otherwise. If the decision to contract is determined by unobservable variables (management ability, regional characteristics, etc.) that also affect performance, the error terms in (3) and (4) will be correlated, leading to biased estimates of κ (and β). We account for this selection bias by assuming a joint normal error distribution, where ρ is the covariance of the errors. To derive a consistent estimates of κ and β we use a two-stage approach starting with a logit estimation of (4). In the second stage, estimates of γ are used to compute the inverse Mills ratio, which is included as an additional term in an OLS estimation of (3) (Greene, 1993).⁶

The result of the first-stage binomial logit estimation of (4) are presented in Table 2. The table presents the marginal effects of each factor on the probability of contracting.⁷ Estimation

⁶ The inverse Mills ratio is defined as $\lambda_i = \frac{\phi(\alpha_i)}{1 - \Phi(\alpha_i)}$, where $\alpha_i = -Z_i \gamma$.

⁷ The marginal effects on $\text{Prob}[Y = 0]$ are the partial derivatives of probabilities with respect to the vector of characteristics. They are computed at the means of the X's.

Table 2
Logit model maximum likelihood estimation: contract/no contract

| Variable | Coefficient marginal effects | Standard error | <i>t</i> -ratio | <i>p</i> -value |
|--|------------------------------------|-------------------|-----------------|-----------------|
| Constant | 0.108 | 0.251 | 0.433 | 0.665 |
| Age (years) | 0.000 | 0.003 | 0.081 | 0.935 |
| Education (years) | −0.045 | 0.016 | −2.879 | 0.004 |
| Years in hog business | −0.011 | 0.003 | −3.832 | <0.000 |
| Total farm assets (100,000 US\$) | 0.220 | 0.070 | 3.175 | 0.001 |
| Primary occupation off-farm | 0.000 | 0.003 | −0.151 | 0.880 |
| Scale class 2 | 0.518 | 0.088 | 4.843 | <0.000 |
| Scale class 3 | 0.566 | 0.089 | 5.230 | <0.000 |
| Scale class 4 | 0.900 | 0.098 | 7.844 | <0.000 |
| Southern/Eastern state | −0.046 | 0.084 | −0.547 | 0.585 |
| Northern state | 0.127 | 0.063 | 1.997 | 0.046 |
| Western state | −0.061 | 0.086 | −0.704 | 0.481 |
| Co. average net return per farm (1,000 US\$) | −0.004 | 0.002 | −2.409 | 0.016 |
| Co. average swine sales per farm (1,000 US\$) | 0.003 | 0.001 | 3.222 | 0.001 |
| Sample size | 477 | | | |
| McFadden pseudo R^2 | 0.41 | | | |
| Chi-squared [13] (<i>p</i> -value) | 231.2 (<0.000) | | | |

Note: The model correctly predicts the contract/no contract decision for 194 of the 233 independent producers and for 195 of the 244 contract producers.

results indicate that for an average operation, an increase in years of experience in the hog business lowers the probability that the farmer will contract, as does an additional year of education. Having a primary occupation off-farm increases the likelihood of contracting.

County-level measures of income and hog farm concentration are included in the regression as measures of the availability, and, consequently, the net benefits of contracting to growers. Contractors choose to locate and expand production in regions where they can operate most profitably—where the opportunity costs to hog farming are low, or where there is a high density of hog producers, which lowers transaction costs. While most hog farmers may have some opportunity to contract, the net benefits of contracting will be higher where the availability of contracting is greater. As expected, being located in a county with more hog production increases the likelihood of contracting, and being in a county with a higher average net return to farming lowers the probability that a farmer contracts. The probability of contracting increases at a decreasing rate with the scale of production.

The results of the second-stage selection model (3) are presented in Table 3. The variables associated with an increase in net returns include year in the hog business, being located in a Western state, and a larger scale of production. The results also show that after correcting for observable operator, operation, and regional factors, and for unobservables correlated with the decision to contract and net returns, contracting raised net returns by 17.91 US\$ per hundredweight of hog produced

Table 3
Sample selection model two stage least-squares regression

| | Coefficient | Standard error | Coefficient standard error | <i>p</i> -value |
|-------------------------------------|----------------|-------------------|----------------------------------|-----------------|
| Constant | −44.596 | 11.370 | −3.922 | 0.000 |
| Age (years) | 0.087 | 0.122 | 0.717 | 0.473 |
| Education (years) | −0.298 | 0.707 | −0.421 | 0.674 |
| Years in hog business | 0.245 | 0.127 | 1.930 | 0.054 |
| Total farm assets (100,000 US\$) | 1.634 | 3.128 | 0.522 | 0.602 |
| Primary occupation off-farm | −0.118 | 0.123 | −0.962 | 0.336 |
| Scale class 2 | 15.715 | 3.608 | 4.356 | 0.000 |
| Scale class 3 | 23.711 | 4.278 | 5.543 | 0.000 |
| Scale class 4 | 25.820 | 6.804 | 3.795 | 0.000 |
| Southern/Eastern state | −0.375 | 3.205 | −0.117 | 0.907 |
| Northern state | −4.503 | 2.766 | −1.628 | 0.104 |
| Western state | 6.541 | 3.266 | 2.003 | 0.045 |
| Contract | 17.914 | 8.756 | 2.046 | 0.041 |
| Lambda | −5.227 | 5.222 | −1.001 | 0.317 |
| Sample size | 477 | | | |
| Adjusted R^2 | 0.28 | | | |
| F[12, 463] (<i>p</i> -value) | 14.89 (<0.000) | | −1.001 | 0.317 |

Note: Dependent variable is net returns to unpaid labor. Estimated correlation of disturbance in regression and selection criterion (ρ) = −0.242.

in 1998.⁸ With this estimate of the change in income due to contracting in 1998 ($\hat{K}_{98} = \hat{k}_{98q}$), we can use (2) to estimate Y_{98}^C —what net returns would have been for a representative independent producer in 1998 had they contracted.

The expected contract income should change only in response to long-run changes in the expected income of independent production because contract farmers are paid their expected reservation wage—what they expect they could earn as independent producers. What a farmer can expect to earn as an independent producer depends on the expected price, and the expected price depends on past prices, which does not change much over time. Consequently, the estimated contract income in the survey year provides a reasonable estimate for expected contract income ($\bar{Y}_{98}^C \cong Y_{98}^C = Y_{98}^I + \hat{k}_{98q}$).⁹

With no survey information about the variation in contract income available, we express the standard deviation of contract income as a fraction θ of the standard deviation of independent income ($\sigma_C = \theta\sigma_I$). It follows that the coefficient of variation of contract income is a function of the unknown parameter θ , the estimated standard deviation of independent income, and the inverse of the estimated expected contract income ($CV_C = \theta\sigma_I/\bar{Y}^C$). We use three values for the contract risk factor θ : a

⁸ The inverse Mills ratio is not significantly different from zero, indicating that we cannot reject the hypothesis of no correlation between the errors of the selection and the treatment equations.

⁹ This assumption is also reasonable if contracts were very long term—e.g., terms were negotiated for the next 10 years. But long-term contracts are not a necessary assumption. As long as the expected income from independent production does not change, then even if a contract could be renegotiated every year, a farmer would still accept the same contract every year.

low value ($\theta = 0$) which implies that contracts provide perfect insurance; a “best guess” value ($\theta = 0.1$); and a high value ($\theta = 0.2$). These values span the range of values reported in previous studies. For example, Johnson and Foster (1994, p. 399) report standard deviations that are equivalent to values of θ between 0.06 and 0.15 for four different types of hog contracts they consider. Similarly, Martin (1997, p. 272) reports an average value of θ equal to 0.095 for 25 hog producers.

3.3. Other income

Recognizing that hog producers can earn income from other farm and nonfarm sources, we add nonfarm income to the estimates of the mean and coefficients of variation of contract and independent income in (1). We proxy nonhog farm income with nonfarm income for all U.S. farms, which had an average value of 52,628 US\$ in 1998 and a coefficient of variation between 1985 and 1999 of 0.2438 (Mishra et al., 2002). We assume nonhog farm income is statistically independent from hog farm income, so the variance of total household income is simply the sum of the variances of hog and nonhog income.

4. Results

Table 4 presents a summary of the estimated means and standard deviations of net returns for independent and contract hog production and nonhog farm income that are used to compute the risk and autonomy premia. After controlling for operator, operation, and regional characteristics, and for possible sample selection bias, a representative hog farmer is estimated to earn more under contract compared to independent production. As shown in Table 4, the expected net returns from contracting less the expected net returns from independent production is estimated to be 9,848 or 3.68 US\$/cwt (equivalent to 6.8% of the historical price).

Table 4
Estimates of net returns for independent and contract hog production

| | Mean | Standard deviation |
|----------------------------------|--------|--------------------|
| Independent production (Y^I) | | |
| Total (US\$) | 15,838 | 20,197 |
| Per unit (US\$/cwt.) | 5.91 | 7.54 |
| Contract production (Y^C) | | |
| $\theta = 0.0$ | | |
| Total (US\$) | 25,686 | 0 |
| Per unit (US\$/cwt) | 9.59 | 0 |
| $\theta = 0.1$ | | |
| Total (US\$) | 25,686 | 2,187 |
| Per unit (US\$/cwt) | 9.59 | 0.82 |
| $\theta = 0.2$ | | |
| Total (US\$) | 25,686 | 4,373 |
| Per unit (US\$/cwt) | 9.59 | 1.63 |
| Nonhog farm income | | |
| Total (US\$) | 35,903 | 8,753 |

Note: θ is the ratio of the standard deviation of contract income to independent income.

Table 5
Estimated risk and autonomy premia per hundredweight of hogs

| Per-unit risk premium | | | | | | |
|----------------------------------|----------------|--------|----------------|--------|----------------|--------|
| Dollars/cwt (% of average price) | | | | | | |
| R | $\theta = 0.0$ | | $\theta = 0.1$ | | $\theta = 0.2$ | |
| 0.0 | 0.00 | (0.0) | 0.00 | (0.0) | 0.00 | (0.0) |
| 0.5 | 1.32 | (2.4) | 1.30 | (2.4) | 1.27 | (2.4) |
| 1.0 | 2.63 | (4.9) | 2.61 | (4.9) | 2.54 | (4.7) |
| 1.5 | 3.95 | (7.3) | 3.91 | (7.3) | 3.81 | (7.1) |
| 2.0 | 5.26 | (9.8) | 5.22 | (9.7) | 5.08 | (9.5) |
| Per-unit autonomy premium | | | | | | |
| Dollars/cwt (% of average price) | | | | | | |
| R | $\theta = 0.0$ | | $\theta = 0.1$ | | $\theta = 0.2$ | |
| 0.0 | 3.68 | (6.8) | 3.68 | (6.8) | 3.68 | (6.8) |
| 0.5 | 4.99 | (9.3) | 4.98 | (9.3) | 4.95 | (9.2) |
| 1.0 | 6.31 | (11.7) | 6.29 | (11.7) | 6.22 | (11.6) |
| 1.5 | 7.63 | (14.2) | 7.59 | (14.1) | 7.49 | (13.9) |
| 2.0 | 8.94 | (16.6) | 8.90 | (16.6) | 8.76 | (16.3) |

Note: The average price for the 1988–1997 period was 53.75 US\$ in 1998 dollars.

Table 5 presents the risk and autonomy premia per hundredweight of hogs and as a percent of the historical average price. The table presents the estimated premia as functions of the contract risk factor θ and the coefficient of relative risk aversion R . The range of the coefficient of relative risk aversion ($0 \leq R \leq 2$) in Table 5 corresponds to values estimated in the literature. For example, Szpiro (1986) using insurance data estimated that R is between 1.2 and 1.8; Hansen and Singleton (1982) used aggregate data to estimate a value between 0.35 and 1.0; and Newberry and Stiglitz (1981, pp. 101–108) synthesize evidence from several empirical studies to conclude that R is in a range from 1 to 2.

As shown in Table 5, risk-averse independent growers are willing to pay a sizeable risk premium to reduce their income risk to the level enjoyed by contract growers. For example, if contracts reduce income variation by 90% ($\theta = 0.1$) and growers are moderately risk averse ($R = 1$), then growers would be willing to pay a price premium of 2.61 US\$/cwt, or 4.9% of the historical price for the risk-reduction benefits associated with the contract income.

Despite the fact that contracting offers valuable risk reduction to risk-averse growers, farmers who contract can expect to earn more on average than independent producers. This suggests that contracts must include significant financial compensation to growers to induce them to contract—in other words, the autonomy premium is positive and large. As shown in Table 5, we estimate that a moderately risk-averse grower ($R = 1$) must be offered 6.29 US\$/cwt to give up the attributes associated with independent production and accept a contract that reduces his risk by 90% ($\theta = 0.1$). As shown in the table, this autonomy premium is equivalent to 11.7% of the average historical price.

Care should be exercised in assigning specific values to the risk or autonomy premia as the estimates of the risk and

autonomy premia are sensitive to the assumptions about growers' attitudes toward risk R . If we assume that growers are risk neutral ($R = 0$) and therefore place no value on risk reduction, then the autonomy premium exactly equals the increase in expected income from contracting (3.68 US\$/cwt). If growers are quite risk averse ($R = 2$), then the risk and autonomy premium are quite large—equal to 5.22 US\$/cwt and 8.90 US\$/cwt, respectively.

Interpretation of the results should take into account the fact that estimation of the difference in income between contract and independent income, and the estimation of the expected income from independent production are both based on data from only 1 year. The precision of these results could be improved with additional survey information. Nonetheless, the results indicate that over a wide range of assumptions about grower risk aversion and the riskiness of contract returns, the autonomy premia is positive, large enough to be economically important, and of the same order of magnitude as the risk premia. These results, while surprising, are consistent with the findings of Gillespie and Eidman (1998) who took a very different empirical approach.

5. Conclusion

This article uses information on actual returns to contract and independent feeder-to-finish hog production to estimate the nonpecuniary benefits to independent hog production. Using historical price data and a treatment effects model we estimate the change in expected income from contracting, the value of risk reduction from contracts, and the value growers place on the attributes of independent production. We find over a wide range of assumptions that the autonomy premia is positive, large enough to be economically important, and of the same order of magnitude as the risk premia. The results of this study provide evidence that analyses that fail to consider the nonpecuniary rewards associated with alternative business arrangements may ignore important influences on farmer welfare and decision making. The results suggest that not accounting for the value farmers place on autonomy may lead to a significant underestimation of the value of risk reduction or grower risk aversion.

The study suggests several areas for future research. As mentioned in the Introduction, there are many attributes associated with independent production. However, the approach developed here cannot determine the value of these individual attributes. For example, we do not know how much value growers place on the right to make management decisions versus not having to worry about a contractor reneging on a contract. Estimating the value of the components of the autonomy premium would add to our understanding of grower incentives (Gillespie and Eidman, 1998). Second, the approach used in this article does not account for the fact that growers have options for managing price risk—such as futures markets—that would reduce the insurance value of production contracts for independent growers. In addition, this study uses a representative farmer approach to derive estimates of the risk and autonomy premia, which

cannot account for the likelihood that contractees are more risk averse and have weaker preferences for autonomy than independent growers. Future work could explore these methodological issues.

A better understanding of growers' incentives to contract is particularly important in sectors where contracting is gaining prevalence, because the adoption of new business arrangements can have important consequences for economic efficiency and grower welfare. Economists and policy makers have long recognized the importance of risk in farmers' business arrangement decisions, and many agricultural policies have focused on developing infrastructure and marketing information to reduce risk. On the other hand, few studies have taken into account factors besides risk and expected income in analyzing farmers' decisions to contract versus produce independently. This study provides some preliminary evidence that the nonpecuniary attributes of independent production are important in farmers' organizational decisions.

Acknowledgments

The author would like to thank William McBride, Michael Roberts, James MacDonald, and two anonymous reviewers for helpful comments and suggestions. The views expressed are those of the author and do not necessarily correspond to the views or policies of the U.S. Department of Agriculture.

Appendix

Estimating the mean and variance of returns to independent hog production

Using the ARMS survey year (1998) as the base year, and 10 years of monthly finished hog, feeder pig, and feed price data from USDA-NASS, income from independent hog production in month t (0120) can be approximated as

$$Y_t^I = \left(\frac{p_t^q}{p_{98}^q} \right) VOP_{98} - \left[\left(\frac{\phi p_t^c + (1 - \phi) p_t^s}{\phi p_{98}^c + (1 - \phi) p_{98}^s} \right) FC_{98} - \left(\frac{p_{t-3}^p}{p_{98}^p} \right) PC_{98} - OC_{98} \right] TCF * (1 + t), \quad (A.1)$$

where

VOP_{98} = average value of hog production in survey year (1998),

$\frac{p_t^q}{p_{98}^q}$ = ratio of deflated finished hog price in month t to average price in survey year,

$\frac{\phi p_t^c + (1 - \phi) p_t^s}{\phi p_{98}^c + (1 - \phi) p_{98}^s}$ = ratio of feed prices in month t to average feed prices in survey year, where p_t^c and p_t^s are the deflated price of corn and soybean in month t , and ϕ is the share of feed costs comprised of corn,

FC_{98} = average feed costs in survey year,
 $\frac{p_{t-3}^p}{p_{98}^p}$ = ratio of deflated feeder pig prices in month $t-3$ to average price in survey year (survey year average is lagged 3 months: Oct. 1997–Oct. 1998),¹⁰
 PC_{98} = average feeder pig costs in survey year,
 OC_{98} = average costs of all other inputs in survey year (includes the costs of all inputs except unpaid labor, feed, and feeder pigs),
 TCF = technology cost factor—declines over time at a constant rate of 0.1612% per month.

The average independent operation produced 2,678 hundred-weight of hogs, valued at 116,123 US\$ in 1998. Mostly due to low hog prices, total costs in 1998 were actually higher than the value of production resulting in net losses of 28,793 US\$ for the average producer. Total feed costs in 1998 averaged 56,923 US\$—the largest input in the production of hogs, accounting for 39.3% of total costs for an average producer. Corn comprised approximately 75.4% of the feed costs, soybean the remaining 24.6%.¹¹ The second largest input expenditure was on feeder pigs, accounting for 31.6% of total costs in 1998.

References

- Barry, P., Roberts, B., Boehlje, M., Baker, T., 1997. Financing capabilities of independent versus contract hog production. *J. Agr. Lend.* Summer: 8–14.
- Boehlje, M., Ray, J., 1999. Contract vs. independent pork production: does financing matter? *Agr. Finance Rev.* 59, 31–42.
- Boehlje, M., Schrader, L., Hurt, C., Foster, K., Pritchett, J., 2001. The Producer Protection Act—will it protect producers? *Purdue Agr. Econ. Rep.* February, 1–4. Available at <http://www.agecon.purdue.edu/extension/pubs/paer/2001/paer0201.pdf>
- Cavalluzzo, L., 1991. Nonpecuniary rewards in the workplace: demand estimates using quasi-market data. *Rev. Econ. Stat.* 73(3), 508–512.
- Diamond, P., Stiglitz, J., 1974. Increases in risk and in risk aversion. *J. Econ. Theory* 8(3), 337–360.
- Gillespie, J. M., Eidman, V. R., 1998. The effect of risk and autonomy on independent hog producers' contracting decisions. *J. Agr. Appl. Econ.* 30(1), 175–188.
- Greene, W., 1993. *Econometric Analysis*, 2nd ed., Prentice Hall, Englewood Cliffs, NJ, 713–714.
- Grimes, G., Meyer, S., 2002. Hog Marketing Contract Study Summarized. Available at <http://agebb.missouri.edu/mkt/vertstud.htm>
- Goddeeris, J., 1988. Compensating differentials and self-selection: an application to lawyers. *J. Pol. Econ.* 96(2), 410–428.
- Hamilton, B. H., 2000. Does entrepreneurship pay? An empirical analysis of the returns to self-employment. *J. Pol. Econ.* 108(3), 604–630.
- Hansen, L., Singleton, K., 1982. Generalized instrumental variables estimation of nonlinear rational expectations models. *Econometrica*. 50(5), 1269–1286.
- Hayenga, M., Rhodes, V. J., Grimes, G., Lawrence, J. D., 1996. Vertical coordination in hog production. GIPSA-RR 96-5, May.
- Hayenga, M., Schroeder, T., Lawrence, J., Hayes, D., Vukina, T., Ward, C., Purcell, W., 2000. Meat packer vertical integration and contract linkages in the beef and pork industries: an economic perspective. American Meat Institute, Arlington, VA. June.
- Hobbs, J., 1997. Measuring the importance of transaction costs in cattle marketing. *Am. J. Agr. Econ.* 79, 1083–1095.
- Johnson, C. S., Foster, K. A., 1994. Risk preferences and contracting in the US hog industry. *J. Agr. Appl. Econ.* 26(2), 393–405.
- Key, N., Roberts, M., 2002. Losing under contract: transaction-cost externalities and spot market disintegration. Selected paper at the 2002 AAEA annual meetings. Long Beach, California.
- Knoeber, C., Thurman, W., 1995. 'Don't count your chickens . . .': risk and risk shifting in the broiler industry. *Am. J. Agr. Econ.* 77, 486–496.
- Martin, L., 1997. Production contract, risk shifting, and relative performance payments in the pork industry. *J. Agr. Appl. Econ.* 29(2), 267–278.
- Mishra, A., El-Osta, H., Morehart, M., Johnson, J., Hopkins, J., 2002. Income, wealth, and the economic well-being of farm households (Agricultural Economic Report No. 812). United States Department of Agriculture Economic Research Service, Washington, DC.
- McBride, W., Key, N., 2003. Economic and structural relationships in U.S. hog production. *Agriculture Economic Report*, No. 818. USDA-ERS, February.
- Newbery, D., Stiglitz, J., 1981. *The Theory of Commodity Price Stabilization: A Study in the Economics of Risk*. Oxford University Press, Oxford.
- Parcell, J., Langemeier, M., 1997. Feeder-pig producers and finishers: who should contract? *Can. J. Agr. Econ.* 45, 317–327.
- Rothschild, M., Stiglitz, J., 1970. Increasing risk: I. a definition. *J. Econ. Theory*, 2(3), 225–243.
- Szpiro, G., 1986. Measuring risk aversion: an alternative approach. *Rev. Econ. Stat.* 68(1), 156–159.
- USDA, National Agricultural Statistics Service. *Agricultural Prices*. Various Issues.
- USDA-ERS, 2001. *Agricultural Resource Management Survey*. Summarized. Available at <http://www.ers.usda.gov/Briefing/FarmStructure/Questions/Contract.htm>
- Viscusi, W. K., Hersch, J., 2001. Cigarette smokers as job risk takers. *Rev. Econ. Stat.* 83(2), 269–280.

¹⁰ Feeder pig prices before 1996 were only available quarterly. Monthly prices were interpolated.

¹¹ Estimates of corn and soybean shares were derived from the average cost shares of grain and protein, respectively, in total feed costs in the 1998 USDA ARMS.